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# INVESTIGATION OF BIODIESEL (JETROPHA)WITH $AL_2O_3$ IN CI ENGINE

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***ABSTRACT***

***The environment and air is highly polluted because of exhaust emission from automobiles, so the need of the hour is to reduce the exhaust emission. Hence our investigation is to reduce the emission there by controlling the air pollution and to save the environment for happy utilization of the future generation. The experiments were conducted with various blends of diesel and biodiesel, with and without nano particles at different loads and proportions. Our investigation results revealed that the addition of aluminum oxide reduces exhaust emission significantly and also improves complete combustion.***

***KEYWORDS: Diesel, Biodiesel, Aluminum Oxide Nanoparticles & Emissions***

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Original Article

## INTRODUCTION

Diesel engines are widely used for better efficiency and low fuel consumption than petrol engine. In diesel engine biodiesel can be used without any modification of the diesel engine. At the full load condition all emissions were decreased. Biodiesel is easily produced in the rural area, it replaces diesel. M. Kannan et al. [1] studied the diesel engine using biodiesel and addition of aluminium oxide reduced specific fuel consumption and all the emissions. Biodiesel degrades rapidly in the surroundings and nontoxic. Every day increase of oil prices could considerably reduce the cost of diesel fuel and increase the production of biodiesel due to the maximum of biodiesel. B. Premanand et al. [2] studied in the investigation that addition of iron oxide nanoparticles with biodiesel reduced ignition delay and time in burning of the fuel. Sajunutal Frane et al. [3] investigated and studied that adding aluminium oxide with biodiesel improved the properties of the fuels, combustion and reduced exhaust gas pollutants. R. Kannan et al. [4] studied that the decrease in specific fuel results in brake thermal efficiency increase and reduce the exhaust emissions with metal based additive. B. Jothi Thirumal et.al [5] investigated that the addition of cerium oxide reduced exhaust emissions, improved combustion and performance. Ramesh D. K et.al [6] studied that addition of aluminum nanoparticles improved combustion, performance and reduced emissions, different fuel properties in which particulate emissions like sulfur content, density, volatility in the fuel can be changed with the use of fuel additives.

## NOMENCLATURE

### Abbreviations and Acronyms

BSFC - Brake SPECIFIC FUEL CONSUMPTION

BP - Brake Power

IP - Indicated Power

ME - Mechanical Efficiency

BTE - Brake Thermal Efficienc

CO - Carbon Monoxide

HC - Hydrocarbon

NOx - Oxides of Nitrogen

PPM - Parts Per Million

JOME - Jetropha Oil Methyl Ester (Biodiesel)

B10 - Biodiesel10% +90 % diesel

B20 - Biodiesel20% +80 % diesel

B30 - Biodiesel30% +70 % diesel

B100 - Biodiesel100% +0 % diesel

BN10 - Biodiesel10% +90 % diesel+100 mg/l aluminum oxide nanoparticles

BN20 - Biodiesel20% +80 % diesel+100 mg/l aluminum oxide nanoparticles

BN30 - Biodiesel30% +70 % diesel+100 mg/l aluminum oxide nanoparticles

BN100 - Biodiesel100% +0 % diesel+100 mg/l aluminum oxide nanoparticles

### Units

SFC - kg/kW h

BP - kW

CO - % volume

HC - ppm

NOx – ppm

## MATERIALS AND METHODS

### Ultrasonic Vibrator

Ultrasonic vibrator is used to mix aluminum oxide nano particles with biodiesel and its blend.

**Figure 1: Ultrasonic Vibrator**

**Figure 2: JOME Blends with $Al_{2O3}$**

### Gas Analyzer

The engine exhausts CO, HC, NOX were measured with AVL-44 Di gas analyzer, and the exhaust emissions were measured by exhaust gas analyzer. The smoke was measured by AVL-437C smoke meter.


**Figure 3: Gas analyzer**

### List of Materials and Machines Used

- Bio-diesel (Jetropha oil methyl ester).
- Nanoparticles ($Al_2O_3$).
- Ultrasonic vibrator.
- Magnetic stirrer equipment
- Beaker
- Single cylinder C.I diesel engine.
- Gas analyzer.
- Diesel.

### Preparation of Biodiesel with Addition of Nanoparticles

Biodiesel with addition of aluminium oxide nanoparticles 100 mg/l or ppm was prepared by the use of an ultrasonicator for mixing of biodiesel and aluminium nanoparticles.

### Properties of Diesel and Biodiesel

Properties of diesel, biodiesel are shown below in the table.1.

**Table 1: Properties of Diesel, Biodiesel**

| Properties | Diesel | JOME |
|---|---|---|
| Kinematic viscosity @40 °C in Cst | 2.51 | 5.7 |
| Density (kg/m$^3$) At 15(°C) | 834 | 885 |
| Cetane number | 50 | 52 |
| Flash point (°C) | 50 | 161 |
| Specific gravity @ 27 (°C) | 0.840 | 0.882 |

## EXPERIMENTAL SET UP

The experiment conducted on four strokes, air cooled diesel engine. The rated power of the engine was 4.4 kW, at 1500 rpm as constant speed and its pressure 200 bars. Details of the engine specification are given in table 2. The AVL smoke meter 415 used to measure the smoke. AVL- DIGAS 444 five-gas analyzer is used to measure the rest of the pollutants such as NOx, HC and CO emissions. The experimental setup is shown in the figure 1.

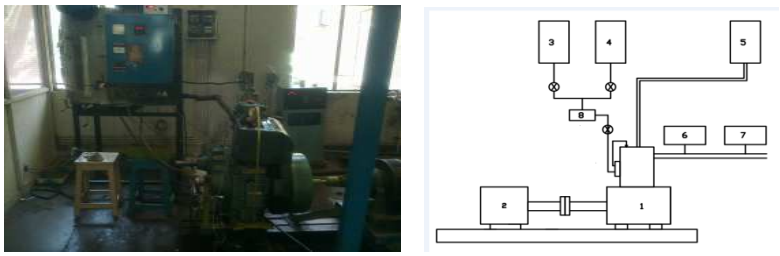


**Figure 4: Experimental Setup**

- Engine
- Electrical dynamometer
- Diesel fuel tank
- Biodiesel fuel tank
- Manometer
- Gas analyzer
- Smoke meter
- Fuel Control valve

**Table 2: Engine Specification**

| Engine Specification | |
|---|---|
| **Type** | **Vertical Air Cooled, Four Stroke** |
| No of cylinder | one |
| Bore diameter | 87.5 mm |
| Stroke | 110 mm |
| Compression ratio | 17.5: 1 |
| Maximum power | 4.4 kW |
| Speed | 1500 rpm |
| Dynamometer | Swing field electrical type |
| Injection timing | 23° (before TDC) |
| Injection pressure | 200 r |

## RESULTS AND DISCUSSIONS

In this investigation, the results of the performance and emission characteristics of the CI engine by using diesel, biodiesel and biodiesel blends were tested and compared with diesel.

### Engine Performance

### Specific Fuel Consumption

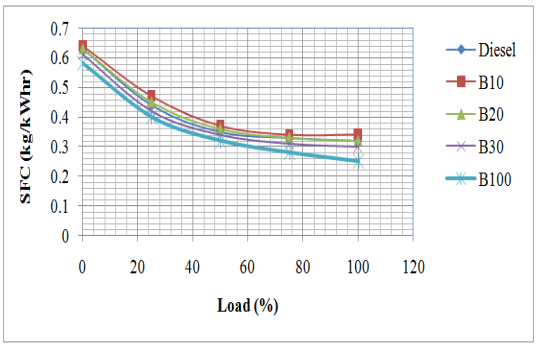


**Figure 5: SFC with Load (without nanoparticles)**

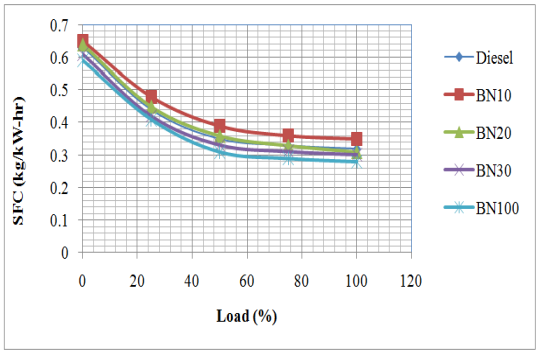


**Figure 6: SFC with Load (With nanoparticles)**

Figure 5 and 6 show the variation of load with specific fuel consumption. Diesel, biodiesel and its blends with and without, addition of aluminium oxide nanoparticles reduces fuel consumption.

### Indicated Power

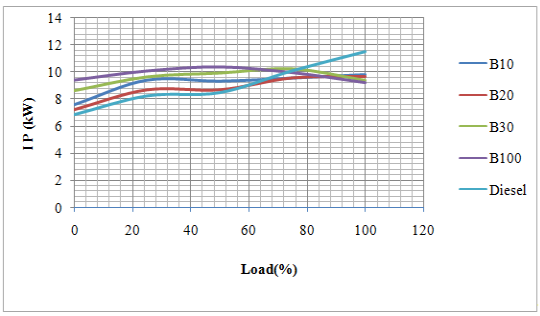


**Figure 7: IP with Load (without nanoparticles)**

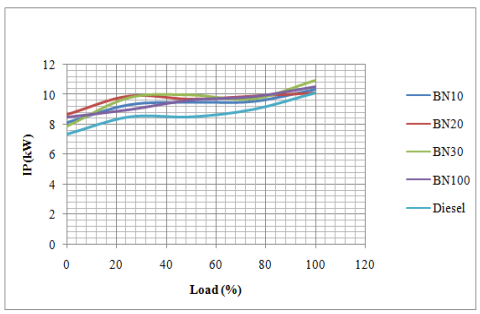


**Figure 8: IP with Load (with nanoparticles)**

Figure 7 and 8 show the variation of the indicated power with load. Diesel, biodiesel and its blends with and without, addition of aluminium oxide nanoparticles increases the indicated power.

**Brake Thermal Efficiency**

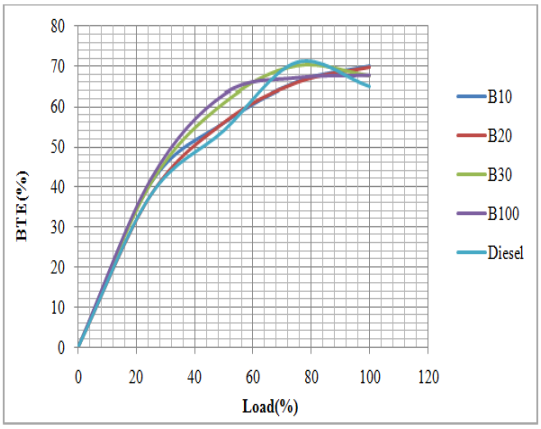


**Figure 9: BTE with Load (without nanoparticles)**

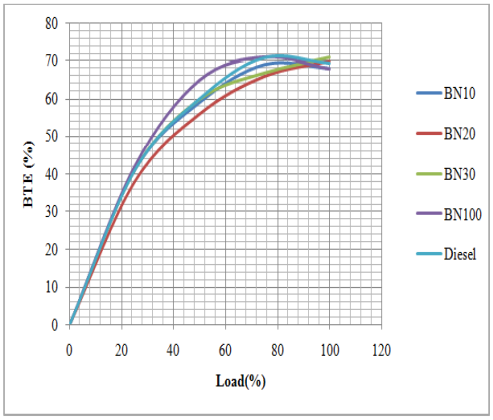


**Figure 10: BTE with Load (with nanoparticles)**

Figure 9 and 10 show the brake thermal efficiency with the load. The brake thermal efficiency of the diesel engine is increased with the load. The aluminium oxide nanoparticles with the biodiesel support complete the combustion and also improved thermal efficiency

**Mechanical Efficiency**

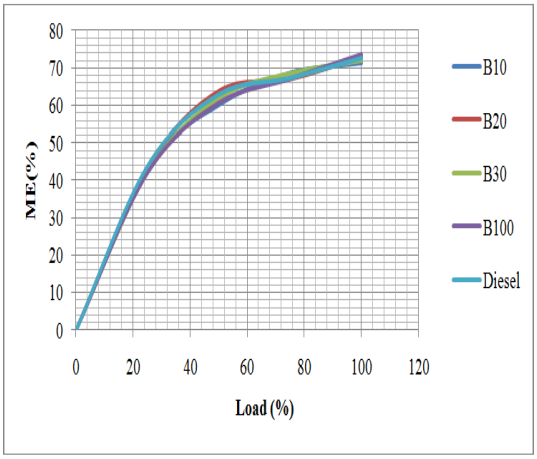


**Figure 11: ME with Load (without nanoparticles)**

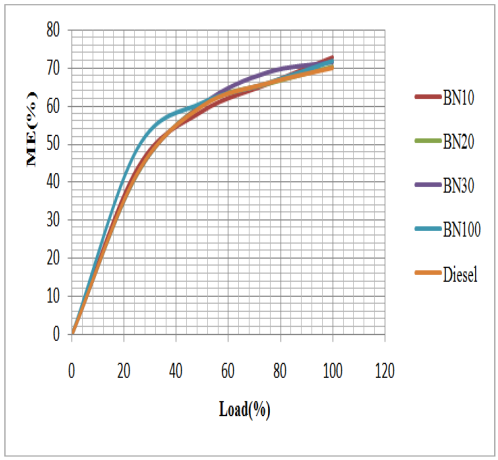


**Figure 12: ME with Load (without nanoparticles)**

Figure 11 and 12 show the mechanical efficiency with the load. The mechanical efficiency of the diesel engine is increased with the load. The aluminium oxide nanoparticles with the biodiesel enhance to support complete combustion and also improve mechanical efficiency.

**Emission Parameters**

**Hydrocarbon**

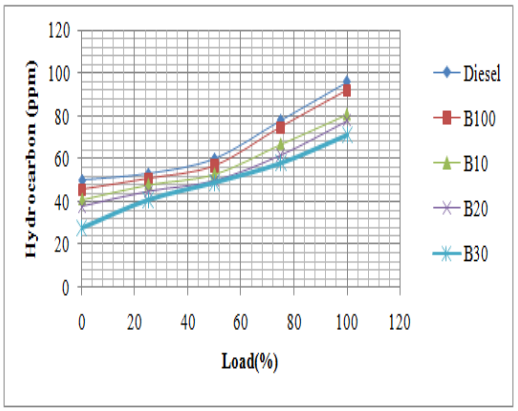


**Figure 13: Hydrocarbon (without nanoparticles)**

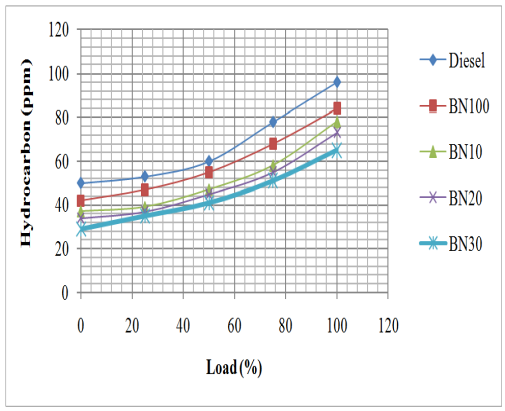


**Figure 14: Hydrocarbon (with nanoparticles)**

Figure 13 and 14 show biodiesel with the addition of nanoparticles increase the level of oxygen. Oxygen substance in the fuel is the most important cause for HC emissions decreased due to the complete combustion. Hydrocarbon emissions were reduced in the biodiesel with the addition of nanoparticles.

**Carbon Monoxide**

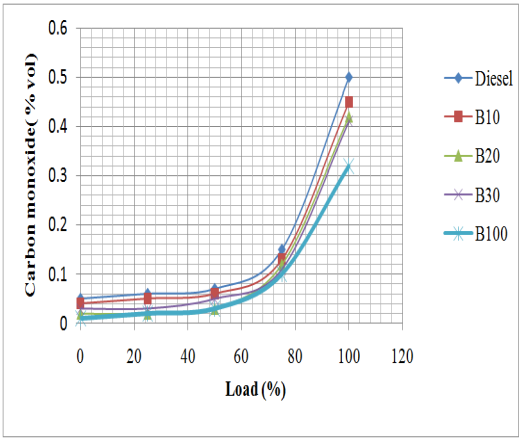


**Figure 15: CO with Load (without nanoparticles)**

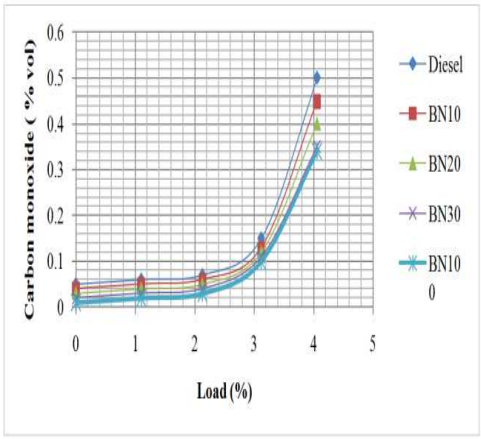


**Figure 16: CO with Load (with nanoparticles)**

Figure 15 and 16 Show variation of Carbon monoxide emission with the load. Aluminium oxide has high area of surface contact that increases reactivity which reduced the ignition delay period. Diesel and biodiesel had decreased the CO emission at lower load condition but for the full load CO emission decreased considerably due to an aluminium oxide additive.

**Smoake**

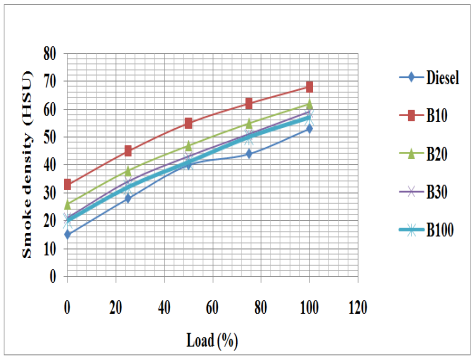


**Figure 17: Smoke with Load (without nanoparticles)**

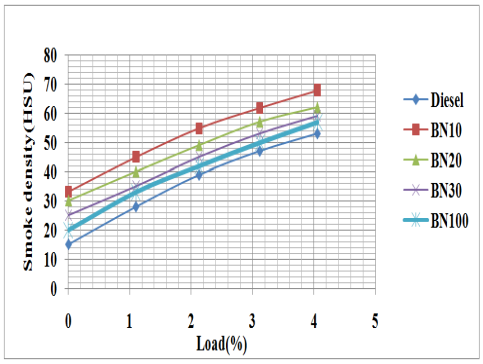


**Figure 18: Smoke with Load (with nanoparticles)**

Figure 17 and 18 show the variation of smoke with the load. Addition of nanoparticles considerably decreases the smoke concentration with respect to biodiesel with the values of the load.

**Oxide of Nitrogen**

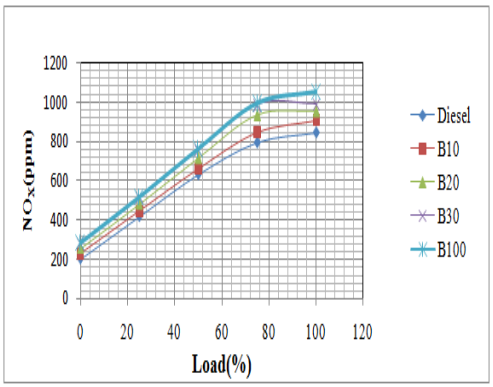


**Figure 19: $NO_X$ with Load (without nanoparticles)**

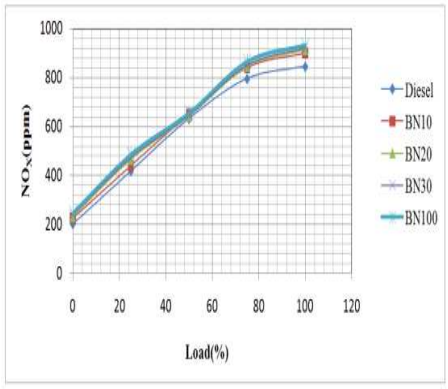


**Figure 20: $NO_X$ with Load (with nanoparticles)**

Figure19 and 20 show an oxide of nitrogen emissions with and without the addition of nanoparticles on biodiesel and its blends. It was seen that NOx steadily rise with all the loads. Biodiesel with addition of aluminum oxide 100 PPM or gm/l shows the lower NOx emission.

## CONCLUSIONS

The performances, emission of diesel engine using biodiesel (JOME) with and without the addition of aluminium oxide were observed. Based on those results, the conclusions were given below: The Specific fuel consumption for the JOME lower than diesel at the entire loads and it was decreased with addition of aluminium oxide. The brake thermal efficiency of JOME increases with the increase in the load and also increases with addition aluminium oxide. The performances, emission of diesel engine using biodiesel (JOME) with and without the addition of aluminiumum oxide were observed. Based on the results, the conclusions were given below:

- The Specific fuel consumption for the JOME lower than diesel at the entire loads and it was decreased with addition of aluminium oxide.
- The brake thermal efficiency of JOME increases with increase the load and also increases with addition aluminium oxide.
- The CO emission reduces with aluminium oxide in JOME
- The addition of aluminium oxide in JOME fuel reduces the HC emissions.
- The smoke emission is decrease with addition of aluminiumm oxide with biodiesel.

## ACKNOWLEDGMENT

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